Publication number : 2001-330837

Date of publication of application : 30.11.2001

Int.Cl. G02F 1/1339 G02F 1/1333 G09F 9/00

G09F 9/30

Application number : 2000-147176

Applicant : MATSUSHITA ELECTRIC IND CO LTD

Date of filing : 19.05.2000

Inventor :

OGAWA KAZUFUMI

A SEALING STRUCTURE AND A FABRICATION METHOD THEREOF, AND A LIQUID CRYSTAL DISPLAY DEVICE USING THE SEALING STRUCTURE AND A FABRICATION METHOD THEREOF

[Abstract]

PROBLEM TO BE SOLVED: To prevent a sealing material from flowing and a seal width from widening in manufacturing an empty cell with printing and pressing of the sealing material in a seal adhesion step.

SOLUTION: The liquid crystal display device 13 is constructed by applying a sealing material 7 to a peripheral part of at least one substrate 1 out of a pair of substrates 1, 10 on which electrodes and alignment layers are formed, by sticking the pair of the substrates 1, 10 to each other keeping a specified gap via the

sealing material 7 and by charging a liquid crystal 11 between the pair of the substrates 1, 10 and is characterized by arranging an inside projecting and recessing pattern 6a along the inside of the pattern of the sealing material 7 and an outside projecting and recessing pattern 6b along the outside of the pattern of the sealing material at least on the one substrate 1 out of the pair of the substrates 1, 10.

[Claim(s)]

[Claim 1] A sealing structure comprising: a pair of substrates; a sealing material bonding predetermined spaced peripheries of a pair of substrates to each other; and an inner uneven pattern along an inside of a sealing material pattern and an outer uneven pattern along an outside of the sealing material pattern, wherein the inner uneven pattern and the outer uneven pattern are formed on at least one of the pair of substrates.

[Claim 2] The sealing structure of claim 1, wherein a middle uneven pattern is formed between the inner uneven pattern and the outer uneven pattern, on at least one of the pair of substrates.

[Claim 3] A sealing structure comprising: a pair of substrates; a sealing material bonding predetermined spaced peripheries of a pair of substrates to each other; and a concave portion formed in the periphery of at least one of the pair of substrates, wherein the sealing material goes into the concave portion.

[Claim 4] The sealing structure of claim 2, wherein the inner uneven pattern, the outer uneven pattern and the middle uneven pattern are formed by means of a film.

[Claim 5] The sealing structure of claim 2 or 4, wherein each edge of the inner uneven pattern, the outer uneven pattern and the middle uneven pattern is flat.

[Claim 6] The sealing structure of claim 2, wherein the middle uneven pattern is plural in number, and a relational expression of $A \leq W \leq B$ is satisfied, wherein A denotes a volume of an area surrounded by two of the middle uneven patterns and the pair of substrates, the volume A is minimum amount required to bond the pair of substrates to each other, B denotes a volume of an area surrounded by the inner uneven pattern, the outer uneven pattern and the pair of substrates, and W denotes a volume of the sealing material.

[Claim 7] A method for fabricating a sealing structure having a pair of substrates, a sealing material bonding a periphery of the pair of substrates to each other by using a predetermined spacing, an inner uneven pattern along an inside of a sealing material pattern and an outer uneven pattern along an outside of the sealing material pattern, wherein the inner uneven pattern and the outer uneven pattern are formed on at least one of the pair of substrates, the method comprising: an uneven pattern forming step of forming the inner uneven pattern and the outer uneven pattern to an inside and outside of a sealing material applying position, respectively, in the periphery of at least one of the pair of substrates; a sealing material applying step of applying linearly the sealing material to the sealing

material applying position; and a bonding step of bonding the pair of substrates each other with a predetermined spacing to harden the sealing material.

[Claim 8] The method of claim 7, wherein in the uneven pattern forming step, a middle uneven pattern is further formed between the inner uneven pattern and the outer uneven pattern on at least one of the pair of substrates.

[Claim 9] A method for fabricating a sealing structure having a pair of substrates, a sealing material bonding peripheries of the pair of substrates each other with a predetermined spacing, and a concave portion formed in the periphery of at least one of the pair of substrates, wherein the sealing material goes into the concave portion, the method comprising: a concave portion forming step of forming the concave portion at the position where sealing material is applied in the periphery of at least one of the pair of substrates; a sealing material applying step of applying linearly the sealing material in the concave portion; and a bonding step of bonding the pair of substrates each other with a predetermined spacing to harden the sealing material.

[Claim 10] The method of claim 7 or 8, wherein in the uneven pattern forming step, a film is formed over the substrate and the film is processed by a photolithography to form the uneven pattern.

[Claim 11] The method of claim 10, wherein the film is formed through a CVD method, a plasma enhanced CVD method, a vacuum evaporation method, a sputtering method, or a sol-gel method.

[Claim 12] The method of claim 10 or 11, wherein the film is a silicon oxide layer or a silicon nitride layer.

[Claim 13] A liquid crystal display device manufactured by applying sealing material to periphery of at least one of a pair of substrates where an electrode and an alignment layer are formed, bonding the pair of substrates each other by using a predetermined spacing while interposing the sealing material therebetween, and injecting a liquid crystal between the pair of substrates, the liquid crystal display device comprising: an inner uneven pattern along an inside of a sealing material pattern; and an outer uneven pattern along an outside of the sealing material pattern, wherein the inner uneven pattern and the outer uneven pattern are formed on at least one of the pair of substrates.

[Claim 14] The liquid crystal display device of claim 13, wherein a middle uneven pattern is formed between the inner uneven pattern and the outer uneven pattern, on at least one of the pair of substrates.

[Claim 15] A liquid crystal display device manufactured by applying sealing

material to a periphery of at least one of a pair of substrates, wherein an electrode and an alignment layer are formed, bonding the pair of substrates each other by using a predetermined spacing while interposing the sealing material therebetween, and injecting a liquid crystal between the pair of substrates, the liquid crystal display device comprising a concave portion formed in the periphery of at least one of the pair of substrates, wherein the sealing material goes into the concave portion.

[Claim 16] The liquid crystal display device of claim 14, wherein the inner uneven pattern, the outer uneven pattern and the middle uneven pattern are formed by means of a film.

[Claim 17] The liquid crystal display device of claim 14 or 16, wherein each edge of the inner uneven pattern, the outer uneven pattern and the middle uneven pattern is flat.

[Claim 18] The liquid crystal display device of claim 14, wherein the middle uneven pattern is plural in number, and a relational expression of $A \leq W \leq B$ is satisfied, where A denotes a volume of an area surrounded by two of the middle uneven pattern and the pair of substrates, the volume A is minimum amount required to bond the pair of substrates to each other, B denotes a volume of an area surrounded by the inner uneven pattern, the outer uneven pattern and the pair of substrates, and W denotes a volume of the sealing material.

[Claim 19] The liquid crystal display device of claim 13, wherein the inner uneven pattern and the outer uneven pattern surround a display part formed in one of the pair of substrates.

[Claim 20] The liquid crystal display device of claim 19, wherein the inner uneven pattern and the outer uneven pattern intersect a connection line extending from the display part outward of the substrate.

[Claim 21] A method for fabricating a liquid crystal display device manufactured by applying a sealing material to a periphery of at least one of a pair of substrates where an electrode and an alignment layer are formed, bonding the pair of substrates each other with a predetermined spacing while interposing the sealing material therebetween, and injecting a liquid crystal between the pair of substrates, the liquid crystal display device comprising an inner uneven pattern along an inside of a sealing material pattern and an outer uneven pattern along an outside of the sealing material pattern, wherein the inner uneven pattern and the outer uneven pattern are formed on at least one of the pair of substrates, the method comprising: an electrode forming step forming the electrode on the pair of substrates; an alignment layer forming step of forming the alignment layer on the pair of substrates; an uneven pattern forming step of forming the inner uneven pattern and the outer uneven pattern to an inside and outside of a sealing material applying

position, respectively, in the periphery of at least one of the pair of substrates while leaving a liquid crystal injection hole; a sealing material applying step of applying linearly the sealing material to the sealing material applying position while leaving the liquid crystal injection hole; and a bonding step of bonding the pair of substrates each other with a predetermined spacing to harden the sealing material.

[Claim 22] The method of claim 21, wherein the uneven pattern forming step, a middle uneven pattern is further formed between the inner uneven pattern and the outer uneven pattern on at least one of the pair of substrates.

[Claim 23] A method for fabricating a liquid crystal display device manufactured by applying a sealing material to a periphery of at least one of a pair of substrates where an electrode and an alignment layer are formed, bonding the pair of substrates each other with a predetermined spacing while interposing the sealing material therebetween, and injecting a liquid crystal between the pair of substrates, the liquid crystal display device comprising a concave portion formed in the periphery of at least one of the pair of substrates, wherein the sealing material goes into the concave portion, the method comprising: an electrode forming step of forming the electrode on the pair of substrates; an alignment layer forming step of forming the alignment layer on the pair of substrates; a concave portion forming step of forming the concave portion at a sealing material applying position in the

periphery of at least one of the pair of substrates; a sealing material applying step of applying linearly the sealing material in the concave portion; and a bonding step of bonding the pair of substrates each other with a predetermined spacing to harden the sealing material.

[Claim 24] The method of claim 21 or 22, wherein in the uneven pattern forming step, a film is formed over the substrate and the film is processed by a photolithography to form the uneven pattern.

[Claim 25] The method of claim 24, wherein the film is formed through a CVD method, a plasma enhanced CVD method, a vacuum evaporation method, a sputtering method, or a sol-gel method.

[Claim 26] The method of claim 24 or 25, wherein the film is a silicon oxide layer or a silicon nitride layer.

[Claim 27] The method of claim 21 or 22, wherein the alignment layer further comprises a step of forming the alignment layer to an inside of the pair of substrates is performed after the uneven pattern forming step.

[Title of the Invention]

A SEALING STRUCTURE AND A FABRICATION METHOD THEREOF, AND A LIQUID CRYSTAL DISPLAY DEVICE USING THE SEALING STRUCTURE AND A FABRICATION METHOD THEREOF

[Detailed Description of the Invention]

[Field of the Invention]

The present invention relates to a sealing structure, a liquid crystal display device using the sealing structure, and fabrication methods thereof, and more particularly, to a sealing method in bonding a pair of substrates each other while interposing a sealing material therebetween.

[Description of the Prior Art]

Recently, a liquid crystal display device market is expanding on a large scale according to the popularization of a data machine, for example, PC or word processor. First of all, a thin film transistor(TFT)-liquid crystal display device fabricated using an amorphous silicon layer as an active layer becomes larger with surprising.

According to the enlargement of the liquid crystal display device, the size of

the used glass substrate becomes larger to help improving the other performance, however, the sealing method in manufacturing a liquid crystal cell is scarcely improved.

A sealing method of a prior art will be explained using a liquid crystal display device of an active matrix type as an example, referring to FIG. 16 to 18. FIG. 16 is a schematic plan view of the prior art liquid crystal display device, FIG. 17 is a schematic plan view showing an array substrate of the prior art liquid crystal display device, and FIG. 18 is a cross section view taken along the D-D line in FIG. 16. In the liquid crystal display device of the active matrix type 13, a liquid crystal material 11 is sealed between an array substrate 1 and a color filter substrate 10, interposing alignment layers 8. A plurality of source line 3 and a plurality of gate line 2 are arranged in a matrix form on the array substrate 1, a thin film transistor(TFT) 15 is arranged at each intersection point of the gate lines 2 and the source lines 3, and pixel electrodes 14 are connected with the source lines 3 and the gate lines 2.

This liquid crystal display device is fabricated as follows.

(1) The array substrate 1 and the color filter substrate 10 are manufactured through a predetermined process.

(2) Sphere-shaped spacers are diffused to the array substrate 1 or the color filter substrate 10.

(3) The sealing material 7 is applied to a periphery of the array substrate 1 or the color filter substrate 10 in the shape of frame, and both substrates are bonded each other.

(4) The bonded substrates 1, 10 are compressed to harden the sealing material 7, and a liquid crystal cell sealing the liquid crystal material 11 is assembled.

(5) The liquid crystal material 11 is injected into the gap between both substrates 1, 10 through the liquid crystal injection hole, and then the liquid crystal injection hole is sealed with the sealing material 12.

During the (3) process, an epoxy-based sealing material is screen printed using a screen printing plate or is drawing coating using a dispenser, to the periphery of the array substrate 1 or the color filter substrate 10.

[Problem(s) to be solved by the Invention]

However, in case of the screen printing and also drawing coating using a dispenser, the applied sealing material is scattered and the distribution of the sealing material amount shows an irregularity according to the applied position. In this condition, when the array substrate 1 and the color filter substrate 10 are compressed interposing the sealing material 7 therebetween in the bonding process, the sealing material width becomes wide at the position where the sealing

material is applied more in amount.

Moreover, the sealing material can overflow from more applied position into the display part, thereby causing a loss of display efficiency. Therefore, the sealing material must be applied to the safe position where the sealing material will not overflow into the display part, as a result, it is interrupted to make the substrate (that is, the liquid crystal display device) compact in size.

In case of loading a driving circuit for TFT driving on the periphery of the array substrate, it is hard to load the driving circuit on the array substrate 1 because the sealing material spreads out into the loading position of the driving circuit. Accordingly, the array substrate having too large size decided by regarding the spreading amount of the sealing material width must be used, as a result, it is interrupted to make the substrate (that is, the liquid crystal display device) compact in size.

Further, as the gate line 2 or the source line 3 are arrange on the array substrate 1, the sealing material width becomes wide especially at the vicinity of the gate line 2 or the source line 3. FIG. 19 is a cross section view showing the vicinity of the sealing material applied position in an array substrate of a prior art, FIG. 20 is a schematic perspective view illustrating the state that the sealing material is applied to the sealing material applied position of FIG. 10 and then the array

substrate and the color filter substrate are compressed, and FIG. 21 is a cross section view taken along the E-E line in FIG. 20. In FIG. 20, the color filter substrate 10 is omitted for convenience of explanation.

As shown in FIG. 19 to 21, on the array substrate 1, the gate line 2 or the source line (not drawn) intersects the sealing material 7, extending outward of the array substrate 1. Accordingly, when the color filter substrate 10 is compressed with the array substrate 1 during the bonding process, the sealing material 7 overflows along the extending direction of the gate lines 2 (X direction) and the sealing material width becomes wide.

Therefore, the present invention has been proposed to solve the above problems and the object of the present invention is to provide a sealing structure being made compact in size by reducing the sealing material width, a liquid crystal display device using the sealing structure, and fabrication methods thereof.

[Means for Solving the Problem]

In order to solve the problem, the present invention described in claim 1 provides a sealing structure comprising a pair of substrates, a sealing material bonding a periphery of the pair of substrates each other with a predetermined spacing, and an inner uneven pattern along an inside of a sealing material pattern and an outer uneven pattern along an outside of the sealing material pattern,

wherein the inner uneven pattern and the outer uneven pattern are formed on at least one of the pair of substrates.

As described above, the present invention can prevent the sealing material width from widening due to the inner uneven pattern and the outer uneven pattern because the inner uneven pattern and the outer uneven pattern are formed along the inside and outside of the sealing material pattern, respectively. In the prior art, the amount of the sealing material applied on the substrate varies with the applied position, when the pair of substrates is bonded each other in that condition, thereby generating an irregularity of the sealing material width according to the applied position. However, in the present invention, due to the formation of the inner and outer uneven pattern, the sealing material spreads out from more applied position to less applied position along the inner and outer uneven pattern, thereby reducing the irregularity of the sealing material and leveling out the sealing material width.

The present invention described in claim 2 provides the sealing structure described in claim 1, wherein a middle uneven pattern is formed between the inner uneven pattern and the outer uneven pattern, on at least one of the pair of substrates.

As described above, it is possible to function as a spacer sustaining the pair of substrates with the middle uneven pattern and the sealing material (more

particularly, the pair of substrates is sustained with the middle uneven pattern and spacers included in the sealing material). Accordingly, the sealing structure in which gap between the pair of substrates is controlled to be uniform is obtained due to the middle uneven pattern and the sealing material. Further, the middle uneven pattern prevents the sealing material width from widening.

The present invention described in claim 3 provides a sealing structure comprising a pair of substrates, a sealing material bonding a periphery of the pair of substrates each other with a predetermined spacing, and a concave portion formed in the periphery of at least one of the pair of substrates, wherein the sealing material goes into the concave portion.

As described above, the present invention can reduce the sealing material width because it is prevented that the sealing material width widens in bonding the pair of substrates each other, due to the concave portion.

The present invention described in claim 4 provides the sealing structure described in claim 2, wherein the inner uneven pattern, the outer uneven pattern and the middle uneven pattern are formed by means of a film.

Accordingly, uniformity is improved because the uneven patterns are formed by means of the film, thus, the gap of the sealing structure can be controlled to be uniform. Moreover, the uneven pattern formed by means of the film can be made its

thickness less and it is applicable to a case that the gap between the pair of substrates is thin.

The present invention described in claim 5 provides the sealing structure described in claim 2 or 4, wherein each edge of the inner uneven pattern, the outer uneven pattern and the middle uneven pattern is flat.

As described above, since the edge of the uneven pattern is flat and the flat portion of the uneven pattern is in parallel with the substrate surface, the foregoing spacer included in the sealing material is easily placed on the uneven pattern. Accordingly, the gap of the sealing structure is easily controlled, so that, the gap can be controlled to be uniform.

The present invention described in claim 6 provides the sealing structure described in claim 2, wherein the middle uneven pattern is plural in number, and a relational expression of $A \leq W \leq B$ is satisfied, where A denotes a volume of an area surrounded by two of the middle uneven pattern and the pair of substrates, the volume A is minimum quantity requiring to bond the pair of substrates each other, B denotes a volume of an area surrounded by the inner uneven pattern, the outer uneven pattern and the pair of substrates, and W denotes a volume of the sealing material.

By restricting as described above, the pair of substrates can be tightly

bonded and something sealed within the sealing structure (for example, gas or liquid) does not leak out of the sealing structure because the volume of the sealing material W is over A. Further, since the volume of the sealing material W is below B, the sealing material does not overflow out of the uneven pattern in compressing the pair of substrate, thereby providing the sealing structure having the sealing material width being within a certain range.

The present invention described in claim 7 provides a method for fabricating a sealing structure having a pair of substrates, a sealing material bonding a periphery of the pair of substrates each other with a predetermined spacing, an inner uneven pattern along an inside of a sealing material pattern and an outer uneven pattern along an outside of the sealing material pattern, wherein the inner uneven pattern and the outer uneven pattern are formed on at least one of the pair of substrates, the method comprising an uneven pattern forming step of forming the inner uneven pattern and the outer uneven pattern to an inside and outside of a sealing material applying position, respectively, in the periphery of at least one of the pair of substrates, a sealing material applying step of applying linearly the sealing material to the sealing material applying position, and a bonding step of bonding the pair of substrates each other with a predetermined spacing to harden the sealing material.

As described above, it is prevented that the sealing material width widens in the bonding step, due to the inner and outer uneven pattern formed at the inside and outside of the sealing material, respectively, and the sealing material width does not widen beyond an interval between the uneven patterns (a predetermined interval). Further, the sealing material spreads out from more applied position to less applied position along the inner and outer uneven pattern, thereby providing the sealing structure having the sealing material width being leveled out.

The present invention described in claim 8 provides the method for fabricating the sealing structure described in claim 7, wherein in the uneven pattern forming step, a middle uneven pattern is further formed between the inner uneven pattern and the outer uneven pattern on at least one of the pair of substrates.

As described above, it is possible to function as a spacer sustaining the pair of substrates with the middle uneven pattern and the sealing material, and to control the gap between the pair of substrates to be uniform in the bonding step. Further, the sealing structure having the reduced sealing material width is obtained because the middle uneven pattern prevents the sealing material width from widening.

The present invention described in claim 9 provides a method for fabricating a sealing structure having a pair of substrates, a sealing material bonding a

periphery of the pair of substrates each other with a predetermined spacing, and a concave portion formed in the periphery of at least one of the pair of substrates, wherein the sealing material goes into the concave portion, the method comprising a concave portion forming step of forming the concave portion at a sealing material applying position in the periphery of at least one of the pair of substrates, a sealing material applying step of applying linearly the sealing material in the concave portion, and a bonding step of bonding the pair of substrates each other with a predetermined spacing to harden the sealing material.

As described above, the present invention can prevent the sealing material width from widening in the bonding step due to the concave portion, thus, decrease the irregularity of the sealing material width according to the applied position, as in the invention described in claim 7.

The present invention described in claim 10 provides the method for fabricating the sealing structure described in claim 7 or 8, wherein in the uneven pattern forming step, a film is formed over the substrate and the film is processed by a photolithography to form the uneven pattern.

As describe above, when the photolithography is employed in forming the uneven pattern, the plural uneven patterns can be formed simultaneously, thereby simplifying the manufacturing process.

The present invention described in claim 11 provides the method for fabricating the sealing structure described in claim 10, wherein the film is formed through a CVD method, a plasma enhanced CVD method, a vacuum evaporation method, a sputtering method, or a sol-gel method.

As describe above, by forming the film through the CVD method, the plasma enhanced CVD method, the vacuum evaporation method, the sputtering method, or the sol-gel method, uniformity in thickness of the film can be improved, accordingly, the gap between the pair of substrates can be easily controlled.

The present invention described in claim 12 provides the method for fabricating the sealing structure described in claim 10 or 11, wherein the film is silicon oxide layer or silicon nitride layer.

As described above, when the film is silicon oxide layer or silicon nitride layer, the gap between the pair of substrates can be easily controlled because the silicon oxide layer and silicon nitride layer have high value in hardness (strong in strength), thereby improving the uniformity of the gap. Further, since a typical semiconductor fabrication process can be used with the silicon oxide layer and silicon nitride layer, the uneven pattern and convex pattern can be formed without adding the manufacturing process.

The present invention described in claim 13 provides a liquid crystal display

device manufactured by applying a sealing material to a periphery of at least one of a pair of substrates where an electrode and an alignment layer are formed, bonding the pair of substrates each other with a predetermined spacing while interposing the sealing material therebetween, and injecting a liquid crystal between the pair of substrates, the liquid crystal display device comprising an inner uneven pattern along an inside of a sealing material pattern and an outer uneven pattern along an outside of the sealing material pattern, wherein the inner uneven pattern and the outer uneven pattern are formed on at least one of the pair of substrates.

In the liquid crystal display device, the sealing material width is prevented from widening in bonding the pair of substrates due to the inner uneven pattern and the outer uneven pattern, the sealing material does not overflow, and the sealing material width can be controlled to be small and uniform. Accordingly, it is achieved to make the liquid crystal display device compact in size.

The present invention described in claim 14 provides the liquid crystal display device described in claim 13, wherein a middle uneven pattern is formed between the inner uneven pattern and the outer uneven pattern, on at least one of the pair of substrates.

The present invention described in claim 15 provides a liquid crystal display device manufactured by applying a sealing material to a periphery of at least one of

a pair of substrates where an electrode and an alignment layer are formed, bonding the pair of substrates each other with a predetermined spacing while interposing the sealing material therebetween, and injecting a liquid crystal between the pair of substrates, the liquid crystal display device comprising a concave portion formed in the periphery of at least one of the pair of substrates, wherein the sealing material goes into the concave portion.

As described above, it is possible to make the sealing material width small because the sealing material width is prevented from widening in bonding the pair of substrates due to the concave portion.

The present invention described in claim 16 provides the liquid crystal display device described in claim 14, wherein the inner uneven pattern, the outer uneven pattern and the middle uneven pattern are formed by means of a film.

The present invention described in claim 17 provides the liquid crystal display device described in claim 14 or 16, wherein each edge of the inner uneven pattern, the outer uneven pattern and the middle uneven pattern is flat.

The present invention described in claim 18 provides the liquid crystal display device described in claim 14, wherein the middle uneven pattern is plural in number, and a relational expression of $A \leq W \leq B$ is satisfied, where A denotes a volume of an area surrounded by two of the middle uneven pattern and the pair of

substrates, the volume A is minimum quantity requiring to bond the pair of substrates each other, B denotes a volume of an area surrounded by the inner uneven pattern, the outer uneven pattern and the pair of substrates, and W denotes a volume of the sealing material.

The present invention described in claim 19 provides the liquid crystal display device described in claim 13, wherein the inner uneven pattern and the outer uneven pattern surround a display part formed in one of the pair of substrates.

As describe above, when the inner uneven pattern and the outer uneven pattern are formed to surround a display part, the sealing material does not overflow into the display part due to the uneven patterns, thereby without loss of display efficiency. Further, since the sealing material does not overflow into the display part, it is possible to apply the sealing material to the closer position to the display part as compared with that of the prior art, thereby the substrate can be used effectively (making the substrate compact in size).

The present invention described in claim 20 provides the liquid crystal display device described in claim 19, wherein the inner uneven pattern and the outer uneven pattern intersect a connection line extending from the display part outward of the substrate.

As described above, since the inner and outer uneven pattern are formed to intersect the connection line extending from the display part outward of the substrate, the overflow of the sealing material along the connection line can be prevented due to the uneven patterns. Therefore, the liquid crystal display device having the reduced sealing material width can be provided, the periphery of substrate can be used effectively, so that it is possible to make the liquid crystal display device compact in size.

The present invention described in claim 21 provides a method for fabricating a liquid crystal display device manufactured by applying a sealing material to a periphery of at least one of a pair of substrates where an electrode and an alignment layer are formed, bonding the pair of substrates each other with a predetermined spacing while interposing the sealing material therebetween, and injecting a liquid crystal between the pair of substrates, the liquid crystal display device comprising an inner uneven pattern along an inside of a sealing material pattern and an outer uneven pattern along an outside of the sealing material pattern, wherein the inner uneven pattern and the outer uneven pattern are formed on at least one of the pair of substrates, the method comprising an electrode forming step of forming the electrode on the pair of substrates, an alignment layer forming step of forming the alignment layer on the pair of substrates, an uneven pattern forming step of forming the inner uneven pattern and the outer uneven

pattern to an inside and outside of a sealing material applying position, respectively, in the periphery of at least one of the pair of substrates while leaving a liquid crystal injection hole, a sealing material applying step of applying linearly the sealing material to the sealing material applying position while leaving the liquid crystal injection hole, and a bonding step of bonding the pair of substrates each other with a predetermined spacing to harden the sealing material.

As describe above, the liquid crystal display device can be fabricated by applying the sealing material while leaving the liquid crystal injection hole, and injecting the liquid crystal into the injection opening. The liquid crystal display device fabricated as described above have the predetermined width of sealing material due to the formation of the inner and outer uneven pattern as in the sealing structure, thereby reducing the irregularity of the sealing material width according to the applied position and leveling out the sealing material width.

The present invention described in claim 22 provides the method for fabricating the liquid crystal display device described in claim 21, wherein in the uneven pattern forming step, a middle uneven pattern is further formed between the inner uneven pattern and the outer uneven pattern on at least one of the pair of substrates.

The present invention described in claim 23 provides a method for

fabricating a liquid crystal display device manufactured by applying a sealing material to a periphery of at least one of a pair of substrates where an electrode and an alignment layer are formed, bonding the pair of substrates each other with a predetermined spacing while interposing the sealing material therebetween, and injecting a liquid crystal between the pair of substrates, the liquid crystal display device comprising a concave portion formed in the periphery of at least one of the pair of substrates, wherein the sealing material goes into the concave portion, the method comprising an electrode forming step forming of the electrode on the pair of substrates, an alignment layer forming step of forming the alignment layer on the pair of substrates, a concave portion forming step of forming the concave portion at a sealing material applying position in the periphery of at least one of the pair of substrates, a sealing material applying step of applying linearly the sealing material in the concave portion, and a bonding step of bonding the pair of substrates each other with a predetermined spacing to harden the sealing material.

As describe above, the present invention can prevent the sealing material width from widening in the bonding step due to the concave portion formed at the sealing material applying position, accordingly, it is possible to obtain the liquid crystal display device having the reduced irregularity of the sealing material width according to the applied position.

The present invention described in claim 24 provides the method for fabricating the liquid crystal display device described in claim 21 or 22, wherein in the uneven pattern forming step, a film is formed over the substrate and the film is processed by a photolithography to form the uneven pattern.

The present invention described in claim 25 provides the method for fabricating the liquid crystal display device described in claim 24, wherein the film is formed through a CVD method, a plasma enhanced CVD method, a vacuum evaporation method, a sputtering method, or a sol-gel method.

The present invention described in claim 26 provides the method for fabricating the liquid crystal display device described in claim 24 or 25, wherein the film is silicon oxide layer or silicon nitride layer.

The present invention described in claim 27 provides the method for fabricating the liquid crystal display device described in claim 21 or 22, wherein the alignment layer forming step of forming the alignment layer to an inside of the pair of substrates is performed after the uneven pattern forming step.

As described above, when the uneven pattern is formed before the alignment layer forming step, the alignment layer is not contaminated by the photolithography. The alignment layer that is not contaminated by the photolithography is clean and shows superior alignment capacity, accordingly, the

liquid crystal display device having high display efficiency can be obtained.

[Embodiment of the Invention]

Reference will now be made in detail to the illustrated embodiments of the present invention, examples of which are illustrated in the accompanying drawings. In the drawings, needless parts to explain are omitted and some parts are drawn to be exaggerated or reduced in scale for convenience of explanation.

(Embodiment 1)

An embodiment 1 of the present invention provides a sealing structure being usable for various purposes referring to FIGS. 1 to 3. FIG. 1 is a schematic drawing of the sealing structure according to the embodiment 1 of the present invention, more particularly, FIG. 1(a) is a perspective view, and FIG. 1(b) is a cross section view taken along the A-A line in FIG. 1(a). FIG. 2 is a plan view showing a substrate that an inner uneven pattern and an outer uneven pattern are formed, and FIG. 3 is a cross section view illustrating a fabrication method of the sealing structure according to the embodiment 1 of the present invention.

In the sealing structure 30 according to the embodiment 1 of the present invention, substrates 31, 32 are bonded each other with a predetermined spacing interposing a sealing material 33 applied to a periphery of the substrate 31 in the shape of frame. In the periphery of the substrate 31, an inner uneven pattern 34a

and an outer uneven pattern 34b are formed along a pattern of the sealing material 33 at an inside and outside of the sealing material pattern, respectively.

As described above, since the inner uneven pattern 34a and the outer uneven pattern 34b are formed along the inside and outside of the sealing material pattern, respectively and in the periphery of the substrate 31, the sealing material 33 is prevented from widening due to the inner uneven pattern 34a and the outer uneven pattern 34b, accordingly, the width of the sealing material 33 can be small (a predetermined interval). Further, the sealing material 33 spreads out from more applied position to less applied position along the inner uneven pattern 34a and the outer uneven pattern 34b, thereby reducing the irregularity of the sealing material 33 and leveling out the sealing material width.

A method for fabricating the sealing structure 30 will be explained.

(1) As shown in FIG. 3(a), the substrate 31 being made up of glass and so on was first prepared, and then, as shown in FIG. 3(b), the inner uneven pattern 34a and the outer uneven pattern 34b were formed to the inside and outside of the sealing material applying position, respectively, in the periphery of the substrate 31 (uneven pattern forming step).

(2) As shown in FIG. 3(c), the sealing material 33 was linearly applied to the periphery of the substrate 31 and between the inner uneven pattern 34a and the

outer uneven pattern 34b(the sealing material applying position) (sealing material applying step).

(3) As shown in FIG. 3(d), the substrate 32 being made up of glass and so on was bonded with the substrate 31 and compressed to harden the sealing material 33, thereby manufacturing the sealing structure 30 (bonding step).

The sealing structure 30 manufactured as described above can be used for various purposes, for example, a glass window in house or a vessel for containing gas or liquid. Further, it can be used in keeping a photograph or picture, when making the spacing between the substrates 31, 32 narrower by controlling the amount of the sealing material. The sealing structure 30 can also be used for a liquid crystal display device, as in an embodiment 2 described below.

The inner uneven pattern 34a and the outer uneven pattern 34b are formed in the periphery of the substrate 31, however, as the other example, a film 31a may be formed on the substrate 31, the inner uneven pattern 34d and the outer uneven pattern 34c may be formed in the film 31a, and the sealing material may be applied between the inner uneven pattern 34d and the outer uneven pattern 34c, as shown in FIG. 4. FIG. 4 is a partial cross section view showing a modified example 1 of the sealing structure according to the embodiment 1 of the present invention. In the modified example 1, although the sealing material 33 is applied between the inner

uneven pattern 34d and the outer uneven pattern 34c and the substrates 31, 32 are compressed in the bonding step, the sealing material 33 goes into the inner uneven pattern 34d and the outer uneven pattern 34c, accordingly, the width of the sealing material 33 is prevented from widening. Further, it is possible to form the inner uneven pattern 34d and the outer uneven pattern 34c in the substrate 31 directly.

FIG. 5 is a partial cross section view showing a modified example 2 of the sealing structure according to the embodiment 1 of the present invention. As shown in FIG. 5, the film 31a is formed on the substrate 31, a concave portion 34e having a predetermined width is formed in the film 31a and at a position where the sealing material 33 is planned to be applied, and the sealing material 33 is applied to the concave portion 34e. Because the sealing material 33 is applied within the concave portion 34e having a predetermined width, the sealing material 33 is prevented from spreading out due to the both ends of the concave portion 34e and the sealing material width does not widen beyond the predetermined width of the concave 34e.

FIG. 6 is a partial cross section view showing a modified example 3 of the sealing structure according to the embodiment 1 of the present invention. As shown in FIG. 6, middle uneven patterns 34f having almost identical shape to the uneven patterns 34a, 34b may be formed between the inner uneven pattern 34a and the outer uneven pattern 34b. Accordingly, it is possible to function as a spacer

sustaining the pair of substrates 31, 32 with the middle uneven pattern 34f and the sealing material 33(more particularly, spacers included in the sealing material 33). Therefore, the sealing structure that the gap between the pair of substrates is controlled to be uniform, is obtained. Here, the number of the middle uneven pattern does not limited. Further, the relation between the sealing material and the middle uneven pattern 34f will be explained referring to FIG. 7.

When the inner uneven pattern 34a, the outer uneven pattern 34b, and two middle uneven patterns 34f are formed at the periphery of the substrate 31 in the shape of four frame, a relational expression of $A \leq W \leq B$ is satisfied, where A denotes a volume of an area surrounded by two middle uneven patterns 34f and the substrates 31 (referring to FIG. 7(a)), the volume A is minimum quantity requiring to bond the pair of substrates each other, B denotes a volume of an area surrounded by the inner uneven pattern 34a formed along the inside of the sealing material 33, the outer uneven pattern 34b formed along the outside of the sealing material 33, and the pair of substrates 31, 32 (referring to FIG. 7(b)), and W denotes a volume of the sealing material (referring to FIG. 7(c)).

Due to the satisfaction of the relational expression as described above, the pair of substrates 31, 32 can be tightly bonded and gas or liquid sealed between the substrates 31, 32 does not leak out. Further, the sealing material does not

overflow due to the inner uneven pattern 34a and the outer uneven pattern 34b.

FIG. 8 is a partial cross section view showing a modified example 4 of the sealing structure according to the embodiment 1 of the present invention. As shown in FIG. 8, the film 31a may be formed on the substrate 31, the inner uneven pattern 34d and the outer uneven pattern 34c may be formed to an inside and outside of a sealing material applying position, respectively, in the film 31a, and the middle uneven patterns 34f may be formed between the inner and outer uneven pattern 34d, 34c. In this case, the middle uneven patterns 34f and the sealing material function as a spacer, and the inner uneven pattern 34d and the outer uneven pattern 34c prevent the sealing material width from widening.

(Others) The inner uneven pattern, the outer uneven pattern, and the middle uneven patterns are formed at the periphery of the substrate 31, but not being confined to there, so that those may be formed at the periphery of the substrate 32 or both substrates 31 and 32.

The sealing material 33 is applied to the periphery of the substrate 31 and between the inner uneven pattern 34c and the outer uneven pattern 34d, but may be formed in the shape of frame by leaving the liquid crystal injection hole (where the sealing material is not applied). The inner uneven pattern, the outer uneven pattern and the middle uneven pattern may be formed from a silicon nitride layer or

a silicon oxide layer, as in the embodiment 2 described below, moreover, those may be formed from a resin and so on. Further, the inner uneven pattern, the outer uneven pattern and the middle uneven pattern may formed through a CVD method, a plasma enhanced CVD method, a vacuum evaporation method, a sputtering method, or a sol-gel method.

(Embodiment 2)

The embodiment 2 of the present invention provides the liquid crystal display device referring to FIGS. 9 to 13.

FIG. 9 is a schematic plan view of the liquid crystal display device according to the embodiment 2 of the present invention, FIG. 10 is a cross section view taken along the B-B line in FIG. 9, FIG. 11 is a cross section view drawn in part of FIG. 10, FIG. 12 is a cross section view taken along the C-C line in FIG. 9, and FIG. 13 is a schematic plan view showing an array substrate 1 in the liquid crystal display device according to the embodiment 2 of the present invention.

In the liquid crystal display device 13 according to the embodiment 2 of the present invention, the array substrate 1 is bonded with a color filter substrate 10 interposing the sealing material 7, and a liquid crystal material 11 is injected into the gap between the array substrate 1 and the color filter substrate 10.

A plurality of source line 3 and a plurality of gate line 2 are arranged in a

matrix form on the array substrate 1, a thin film transistor (TFT) is arranged at each intersection point of the gate lines 2 and the source lines 3, and pixel electrodes 14 are connected with the source lines 3 and the gate lines 2 to constitute a display part 4. Further, a gate line driving circuit and a source line driving circuit that are not drawn are connected with the gate lines 2 and the source lines 3, respectively. The gate line driving circuit and the source line driving circuit may be arranged at the periphery of the array substrate 1. Further, an arrangement layer 8 is formed over the pixel electrodes 14, the thin film transistors(TFT) 15, the gate lines 2 and the source lines 3 formed in that way.

In a periphery of the array substrate 1, an inner uneven pattern 6a and an outer uneven pattern 6b, which constitute the principal part of the present invention, are formed along a pattern of the sealing material 7 at an inside and outside of the sealing material pattern, respectively. The inner uneven pattern 6a and the outer uneven pattern 6b are formed except for a liquid crystal injection hole 5. Further, middle uneven patterns 6c having almost identical shape to the inner uneven pattern 6a and the outer uneven pattern 6b may be formed on the array substrate 1 and between the inner uneven pattern 6a and the outer uneven pattern 6b, except for the liquid crystal injection hole 5. Here, the inner uneven pattern 6a, the outer uneven pattern 6b and the middle uneven patterns 6c make an uneven pattern 6. The uneven pattern 6 is formed to intersect the gate lines 2 or the source lines 3

extending from the display part 4 outward of the substrate.

A color mosaic filter (not drawn) and a common electrode 16 are formed on the color filter substrate 10, and the alignment layer 8 is formed thereon.

The alignment layers 8 formed on each of the array substrate 1 and the color filter substrate 10 is treated to have orientation, and then the array substrate 1 and the color filter are set opposite each other confronting the alignment layers 8, and bonded each other with a predetermined spacing by the sealing material 7 applied in the shape of frame.

The liquid crystal 11 is injected into the gap between the array substrate 1 and the color filter substrate 10 through the liquid crystal injection hole 5, and the liquid crystal 11 is sealed with a sealing material 12. The gate lines 2 and the source lines 3 extend outward of the array substrate 1.

The uneven pattern 6 constituting the principal part of the present invention will be explained. The uneven pattern 6 is composed of the inner uneven pattern 6a, the outer uneven pattern 6b and the middle uneven patterns 6c.

In a periphery of the array substrate 1, the uneven pattern 6 is formed along a pattern of the sealing material 7 at an inside and outside of the sealing material except for a liquid crystal injection hole 5 in the shape of frame. The uneven pattern 6 is formed of a layer, more particularly, silicon oxide layer or silicon nitride layer

having high strength.

As described above, due to the formation of the uneven pattern 6, the sealing material is prevented from overflowing by the inner uneven pattern 6a and the outer uneven pattern 6b (the sealing material 7 does not spread along the extending direction of the gate lines 2 (X direction) or the extending direction of the source lines 3 (Y direction), thereby making the sealing material have a predetermined width.

In the embodiment 2 of the present invention, the inner uneven pattern 6a, the outer uneven pattern 6b and the middle uneven patterns 6c have their width of 1㎛ and height of 1㎛, and the distance between the inner uneven pattern 6a and the outer uneven pattern 6b is 0.5mm. The number of the uneven pattern 6 is not limited to that in this embodiment (four), but can be five or more.

Further, as shown in FIG. 11(b), it is possible to function as a spacer sustaining the pair of substrates 1, 10 with the middle uneven patterns 6c and the sealing material 7 (more particularly, spacers 7a included in the sealing material 7). Accordingly, the gap between the array substrates 1 and the color filter substrate 10 is easily controlled to be uniform. Further, uniformity of the middle uneven patterns 6c is improved because the middle uneven patterns 6c are formed by means of the film that show superior uniformity, moreover, the gap of the liquid crystal display

device can be controlled to be uniform. The uneven pattern formed by means of the film can be made its thickness less and it is applicable to a case that the gap between the pair of substrates is thin, especially the liquid crystal display device.

Since edges of the middle uneven patterns 6c are flat (in parallel with the array substrate 1 and the color filter substrate 10), the gap between the array substrate 1 and the color filter substrate 10 can be controlled to be uniform by the spacers 7a and the middle uneven patterns 6c, in manufacturing the liquid crystal display device. Further, the inner uneven pattern 6a and the outer uneven pattern 6b are formed by means of a film and their edges also are flat.

The sealing material does not overflow into the periphery of the array substrate 1, that is, where the gate line driving circuit and the source line driving circuit are loaded. Therefore, according to the present invention, the sealing material width does not spread out along the gate lines 2 or the source lines 3 outward of the array substrate 1, so that it is not necessary to use the array substrate 1 having too large size decided by regarding the spreading amount of the sealing material, and it is achieved to make the liquid crystal display device 13 compact in size.

The applied sealing material are scattered on the substrate, but it is possible to make the sealing material width have a predetermined width or less due

to the formation of the inner uneven pattern 6a and the outer uneven pattern 6b, although the array substrate 1 and the color filter substrate 10 are compressed interposing the sealing material therebetween in the bonding step, thereby reducing the irregularity of the sealing material width.

A method for fabricating the liquid crystal display device according to the embodiment 2 of the present invention will be explained referring to FIG. 14 and 15. FIG. 14 is a cross section view illustrating the fabrication method of the liquid crystal display device according to the embodiment 2 of the present invention, and FIG. 15 is a partial cross section view illustrating the fabrication method of the liquid crystal display device according to the embodiment 2 of the present invention.

(1) A transparent glass substrate with a thickness of 0.7mm and a size as large as four sides of liquid crystal display device, each of which having a display size of 15 matrix can be manufactured on this transparent glass substrate, was prepared. The transparent glass substrate was cut to manufacture the glass substrate (hereinafter referred as 'array substrate 1') having a display size of 15 matrix.

(2) As shown in FIG. 14(a), the thin film transistors(TFT) 15, the pixel electrodes 14, the gate lines 2 and the source lines (not drawn) were formed on the array substrate 1 by the well-known method.

(3) As shown in FIG. 14(b), in order to protect the thin film transistors 15, a passivation layer 9 being formed of silicon oxide or silicon nitride was formed over the array substrate 1 through the plasma enhanced CVD method or sputtering method.

(4) As shown in FIG. 14(c), by a photolithography, the passivation layer 9 was patterned and the uneven patterns 6 (the inner uneven pattern 6a, the outer uneven pattern 6b and the middle uneven patterns 6c) was formed at the periphery of the array substrate 1 in the shape of frame, at the same time.

(5) As shown in FIG. 14(d), a polyimide resin for the alignment layer was spin coated, heated to harden, and rubbing processed in a predetermined direction to form the alignment layer 8. As described above, when the uneven pattern 6 was formed before the alignment layer forming step, the alignment layer 8 was not contaminated; accordingly, the liquid crystal display device having high display efficiency could be obtained.

(6) As shown in FIG. 15(e), the sealing material 7 was linearly applied on the middle uneven patterns 6c except for the liquid crystal injection hole 5 using a screen printing method.

(7) As shown in FIG. 15(f), the glass substrate 1 and the color filter substrate 10 that the color filter, a counter electrode and the alignment layer are

formed, were set opposite each other confronting the surface of the alignment layer 8 on the color filter substrate 10 with the surface of the alignment layer 8 on the glass substrate 1, and then bonded and compressed to harden the sealing material 7. Here, the sealing material spread naturally, but the overflow of the sealing material 7 was blocked by the inner uneven pattern 6a and the outer uneven pattern 6b being in almost parallel with the sealing material 7, thus the sealing material width could be prevented from widening.

(8) Finally, the predetermined liquid crystal material 11 was vacuum injected through the liquid crystal injection hole 5 and then the liquid crystal injection hole 5 was sealed with the sealing material 12, hereby the liquid crystal display device 13 as shown in FIG. 9 could be fabricated.

Because the length direction of the uneven pattern 6 intersected the gate lines 2 and the source lines 3 formed on the array substrate 1, the sealing material was effectively prevented from widening and did not spread out along the gate lines 2 or source lines 3.

Further, since the uneven pattern 6 was formed to surround a display part 4 of the liquid crystal display device 13, the sealing material did not overflow into the display part due to the uneven pattern 6, thereby without loss of display efficiency. The liquid crystal cell can be made on a portion of the sealing portions.

(Others)

(1) It is possible to form the display part 4 in four sides simultaneously using the substrate with a size as large as four sides, each of which having a display size of 15 matrix can be manufactured on this substrate, to bond the pair of substrates to manufacture a cell, and then to cut the substrate.

(2) The uneven pattern 6 (the inner uneven pattern 6a, the outer uneven pattern 6b, the middle uneven pattern 6c) is formed through the plasma enhanced CVD method, but not being confined to this, it may be formed through CVD method, a vacuum evaporation method, a sputtering method, or a sol-gel method, and also by a photolithography technique.

(3) The uneven pattern being formed from the silicon oxide layer or silicon nitride layer is formed simultaneously with the formation of the passivation layer, but not being confined to this. For example, the resin and so on may be used as the uneven pattern, in this case, the uneven pattern can also be formed before forming the pixel electrode or TFT on the array substrate.

(4) The configuration of the uneven pattern is not confined to the embodiment 1 and 2 of the present invention, but, for example, can be trapezoid shape or triangle shape in cross section shape. The relational expression regarding the uneven pattern and the sealing material amount ($A \leq W \leq B$) as described in the

embodiment 1 may be satisfied also in the embodiment 2.

[Effect of the Invention]

As has been explained, according to the present invention, because the inner uneven pattern and the outer uneven pattern are formed along an inside and outside of the sealing material pattern, the overflow of the sealing material and the widening of the sealing material width can be prevented in bonding the array substrate with the color filter substrate during the bonding step. Accordingly, it is achieved to make the liquid crystal display device compact in size.

[Description of Drawings]

FIG. 1. is a schematic drawing of the sealing structure according to the embodiment 1 of the present invention, FIG. 1(a) is a perspective view, and FIG. 1(b) is a cross section view taken along the A-A line in FIG. 1(a).

FIG. 2. is a plan view showing a substrate that an inner uneven pattern and an outer uneven pattern are formed.

FIG. 3. is a cross section view illustrating a fabrication method of the sealing structure according to the embodiment 1 of the present invention.

FIG. 4. is a partial cross section view showing a modified example 1 of the sealing structure according to the embodiment 1 of the present invention.

FIG. 5 is a partial cross section view showing a modified example 2 of the sealing structure according to the embodiment 1 of the present invention.

FIG. 6. is a partial cross section view showing a modified example 3 of the sealing structure according to the embodiment 1 of the present invention.

FIG. 7. is a cross section view illustrating the relation between the sealing material and the uneven pattern.

FIG. 8 is a partial cross section view showing a modified example 4 of the sealing structure according to the embodiment 1 of the present invention.

FIG. 9 is a schematic plan view of the liquid crystal display device according to the embodiment 2 of the present invention.

FIG. 10 is a cross section view taken along the B-B line in FIG. 9.

FIG. 11 is a cross section view drawn in part of FIG. 10.

FIG. 12 is a cross section view taken along the C-C line in FIG. 9.

FIG. 13 is a schematic plan view showing an array substrate 1 in the liquid crystal display device according to the embodiment 2 of the present invention.

FIG. 14 is a cross section view illustrating the fabrication method of the liquid crystal display device according to the embodiment 2 of the present invention.

FIG. 15 is a partial cross section view illustrating the fabrication method of the liquid crystal display device according to the embodiment 2 of the present invention.

FIG. 16 is a schematic plan view of the prior art liquid crystal display device.

FIG. 17 is a schematic plan view showing an array substrate of the prior art liquid crystal display device.

FIG. 18 is a cross section view taken along the D-D line in FIG. 16.

FIG. 19 is a cross section view showing the vicinity of the sealing material

applied position in an array substrate of a prior art.

FIG. 20 is a schematic perspective view illustrating the state that the sealing material is applied to the sealing material applied position of FIG. 10 and then the array substrate and the color filter substrate are compressed.

FIG. 21 is a cross section view taken along the E-E line in FIG. 20.

[Meaning of numerical symbols in the drawings]

1:array substrate	2:gate line
3:source line	4:display part
5:liquid crystal injection hole	6:uneven pattern
6a:inner uneven pattern	6b:outer uneven pattern
6c:middle uneven pattern	7:sealing material
7a:spacer	8:alignment layer
9:passivation layer	10:color filter substrate
11:liquid crystal material	12:sealing material
13:liquid crystal display device	14:pixel electrode
15:TFT	30:sealing structure
31:substrate	32:substrate

33:sealing material

34a: inner uneven pattern

34b:outer uneven pattern

34c:middle uneven pattern

34d: inner uneven pattern

34e:concave portion